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Fellhauer et al.

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(54) DOMAIN SPECIFIC PROVIDER CONTRACTS FOR CORE DATA SERVICES

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(51) **Int. Cl.**

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H04L 67/53	(2022.01)
G06F 16/27	(2019.01)

(52) **U.S. Cl.**
CPC ***H04L 67/1097*** (2013.01); ***G06F 16/27*** (2019.01); ***H04L 67/53*** (2022.05)

(58) **Field of Classification Search**
CPC H04L 67/1097; H04L 67/53; G06F 16/27
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2015/0074081 A1*	3/2015	Falter	G06F 16/2433	707/713
2015/0074083 A1*	3/2015	Hutzel	G06F 16/2445	707/716
2015/0074136 A1*	3/2015	Falter	G06F 16/288	707/760

(Continued)

FOREIGN PATENT DOCUMENTS

EP	3035212 A1 *	6/2016	G06F 16/182
WO	WO-2022090767 A1 *	5/2022	

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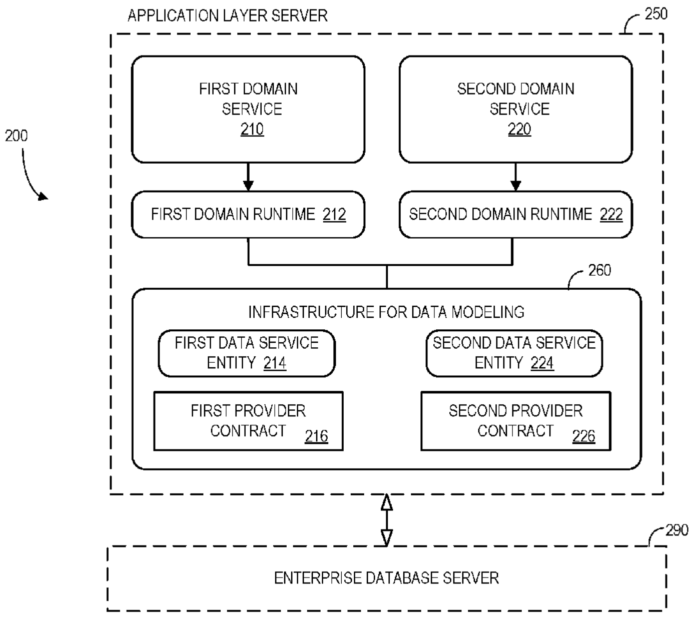
(57) ABSTRACT

An enterprise database server may store enterprise information. An application layer server, coupled to the enterprise database server, may use an application programming language (e.g., ABAP) to access the enterprise information. The application layer server may execute a plurality of domain runtimes, each associated with a domain service (e.g., transactional, SQL, analytical, search, etc.). The application layer server may also access, by a first domain runtime, a first data service entity in an infrastructure for data modelling (e.g., CDS) that enables data models to be defined and consumed on the enterprise database server. Similarly, the application layer server may access, by a second domain runtime, a second data service entity in the infrastructure for data modelling. According to some embodiments, the first data service entity includes a first provider contract and the second data service entity includes a second provider contract (different than the first provider contract).

10 Claims, 9 Drawing Sheets

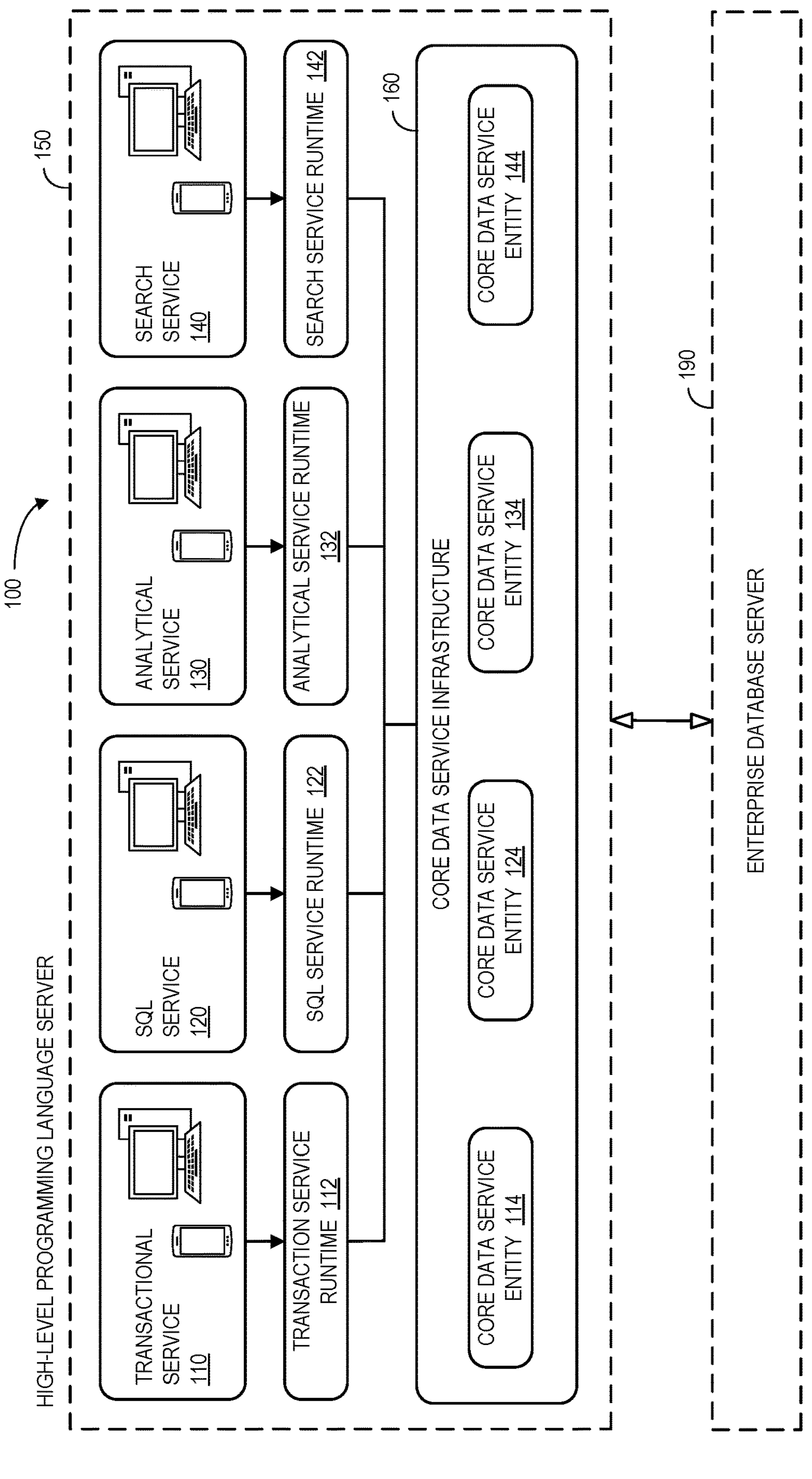

APPLICATION LAYER SERVER
250
200
FIRST DOMAIN SERVICE 210
SECOND DOMAIN SERVICE 220
FIRST DOMAIN RUNTIME 212
SECOND DOMAIN RUNTIME 222
260
INFRASTRUCTURE FOR DATA MODELING
FIRST DATA SERVICE ENTITY 214
SECOND DATA SERVICE ENTITY 224
FIRST PROVIDER CONTRACT 216
SECOND PROVIDER CONTRACT 226
290
ENTERPRISE DATABASE SERVER

(56) **References Cited**

U.S. PATENT DOCUMENTS

2015/0074139	A1*	3/2015	Falter	G06F 16/2456 707/769
2015/0074140	A1*	3/2015	Hutzel	G06F 16/90335 707/769
2015/0293947	A1*	10/2015	Bhagavan	G06F 16/212 707/802
2016/0085659	A1*	3/2016	Schmitt	G06F 11/3616 717/126
2016/0171020	A1*	6/2016	Stork	G06F 16/212 707/803
2018/0210902	A1*	7/2018	Wu	G06F 16/212
2021/0209501	A1*	7/2021	Sarferaz	G06F 9/547
2022/0058517	A1*	2/2022	Cherry	G06N 20/00

* cited by examiner


100
150
HIGH-LEVEL PROGRAMMING LANGUAGE SERVER
TRANSACTIONAL SERVICE 110
SQL SERVICE 120
ANALYTICAL SERVICE 130
SEARCH SERVICE 140
TRANSACTION SERVICE RUNTIME 112
SQL SERVICE RUNTIME 122
ANALYTICAL SERVICE RUNTIME 132
SEARCH SERVICE RUNTIME 142
160
CORE DATA SERVICE INFRASTRUCTURE
CORE DATA SERVICE ENTITY 114
CORE DATA SERVICE ENTITY 124
CORE DATA SERVICE ENTITY 134
CORE DATA SERVICE ENTITY 144
190
ENTERPRISE DATABASE SERVER

PRIOR ART

FIG. 1

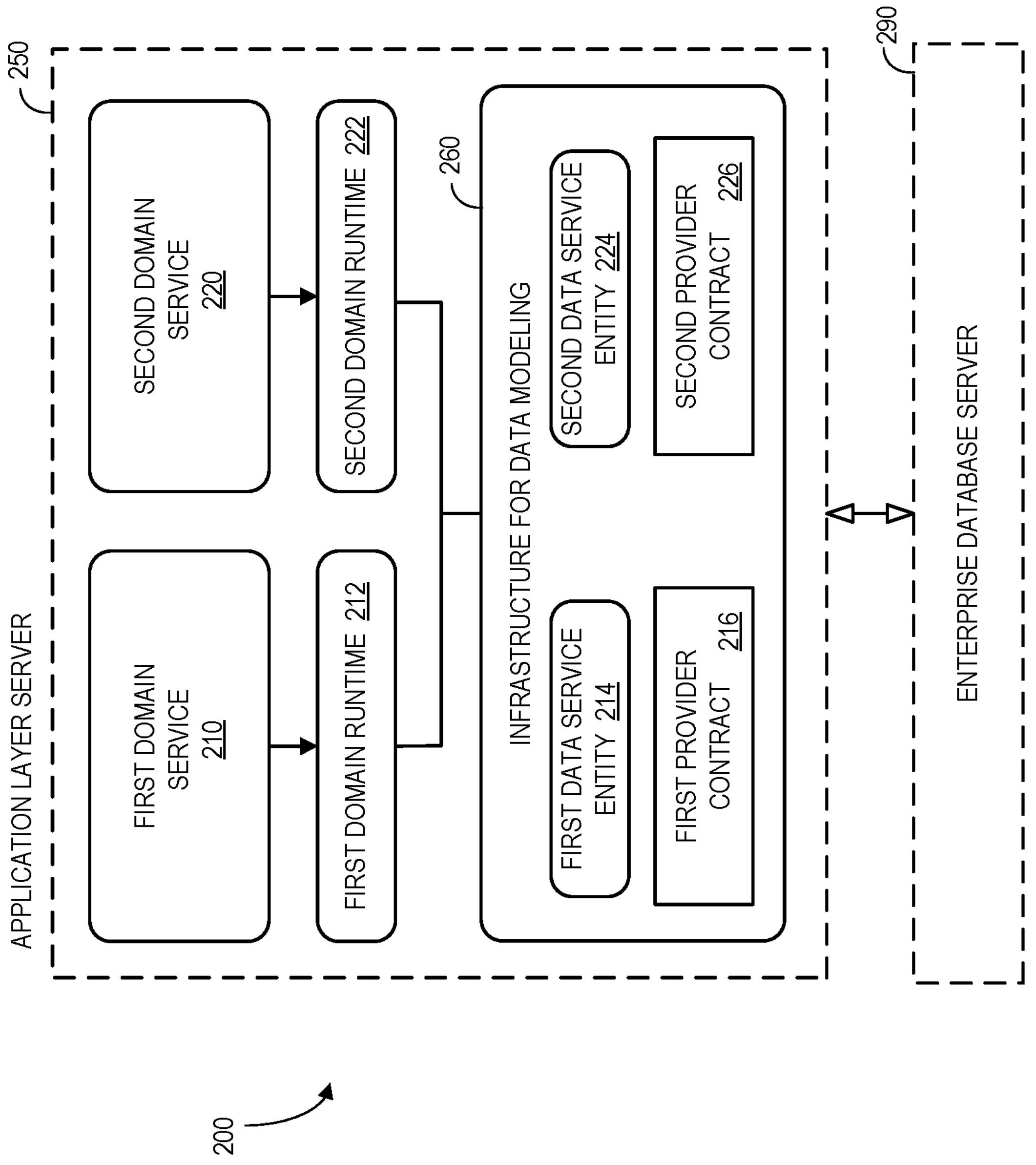

200
250
APPLICATION LAYER SERVER
FIRST DOMAIN SERVICE 210
SECOND DOMAIN SERVICE 220
FIRST DOMAIN RUNTIME 212
SECOND DOMAIN RUNTIME 222
260
INFRASTRUCTURE FOR DATA MODELING
FIRST DATA SERVICE ENTITY 214
SECOND DATA SERVICE ENTITY 224
FIRST PROVIDER CONTRACT 216
SECOND PROVIDER CONTRACT 226
290
ENTERPRISE DATABASE SERVER

FIG. 2

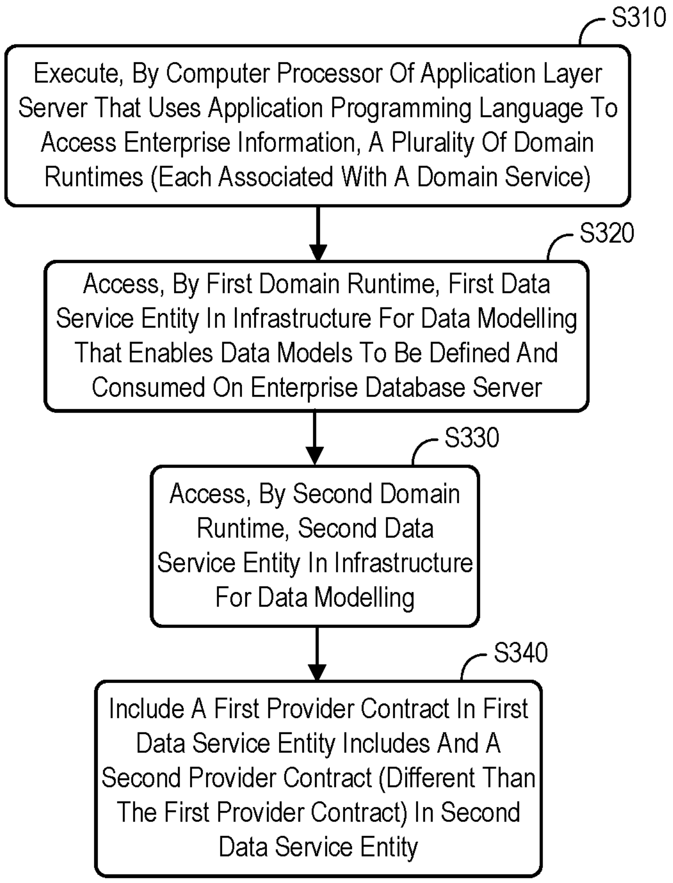

S310
Execute, By Computer Processor Of Application Layer Server That Uses Application Programming Language To Access Enterprise Information, A Plurality Of Domain Runtimes (Each Associated With A Domain Service)
S320
Access, By First Domain Runtime, First Data Service Entity In Infrastructure For Data Modelling That Enables Data Models To Be Defined And Consumed On Enterprise Database Server
S330
Access, By Second Domain Runtime, Second Data Service Entity In Infrastructure For Data Modelling
S340
Include A First Provider Contract In First Data Service Entity Includes And A Second Provider Contract (Different Than The First Provider Contract) In Second Data Service Entity

FIG. 3

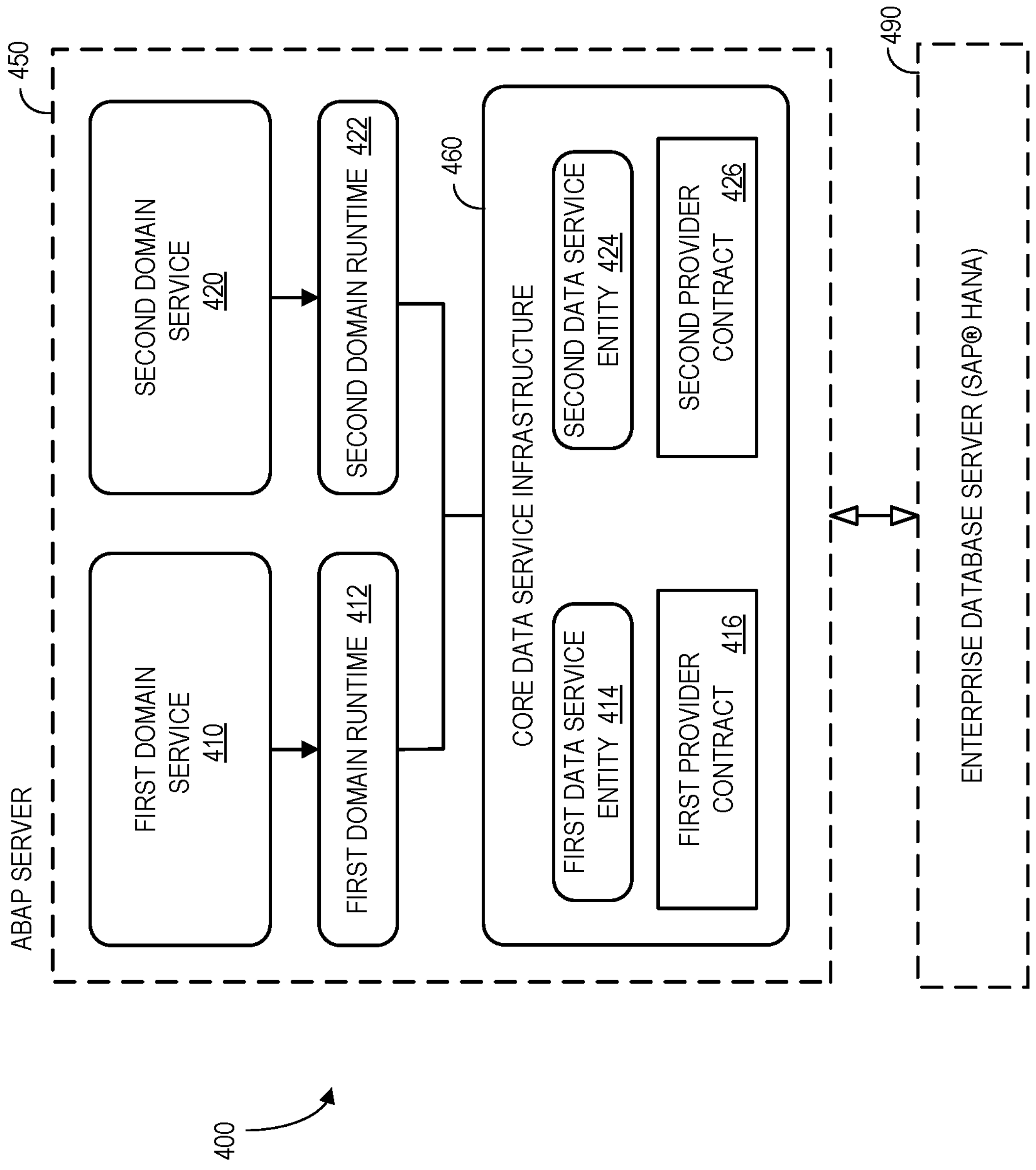

400
ABAP SERVER
450
FIRST DOMAIN SERVICE 410
SECOND DOMAIN SERVICE 420
FIRST DOMAIN RUNTIME 412
SECOND DOMAIN RUNTIME 422
460
CORE DATA SERVICE INFRASTRUCTURE
FIRST DATA SERVICE ENTITY 414
SECOND DATA SERVICE ENTITY 424
FIRST PROVIDER CONTRACT 416
SECOND PROVIDER CONTRACT 426
490
ENTERPRISE DATABASE SERVER (SAP® HANA)

FIG. 4

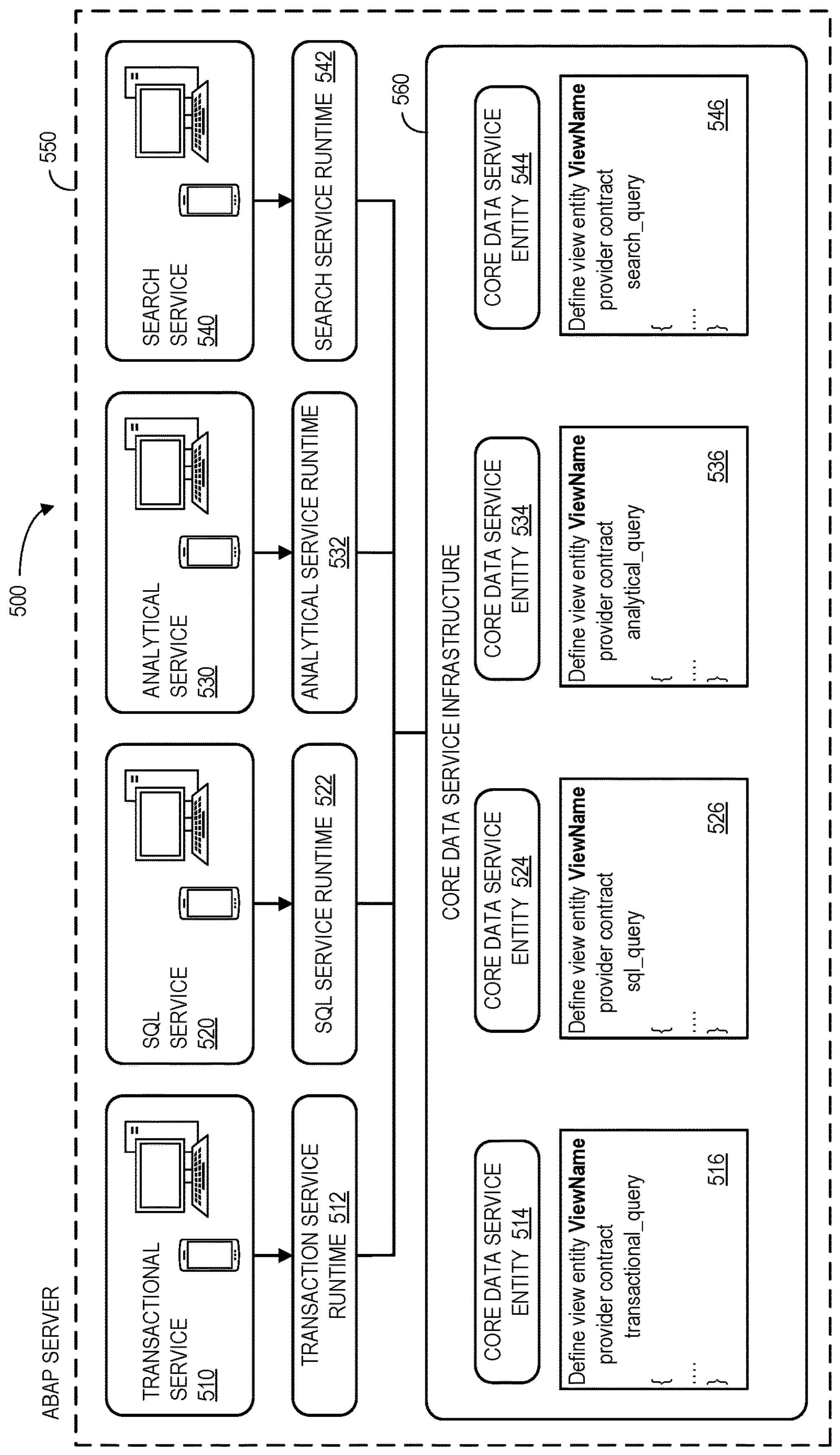

500
550
ABAP SERVER
TRANSACTIONAL SERVICE 510
SQL SERVICE 520
ANALYTICAL SERVICE 530
SEARCH SERVICE 540
TRANSACTION SERVICE RUNTIME 512
SQL SERVICE RUNTIME 522
ANALYTICAL SERVICE RUNTIME 532
SEARCH SERVICE RUNTIME 542
560
CORE DATA SERVICE INFRASTRUCTURE
CORE DATA SERVICE ENTITY 514
CORE DATA SERVICE ENTITY 524
CORE DATA SERVICE ENTITY 534
CORE DATA SERVICE ENTITY 544
Define view entity **ViewName** provider contract transactional_query { .... } 516
Define view entity **ViewName** provider contract sql_query { .... } 526
Define view entity **ViewName** provider contract analytical_query { .... } 536
Define view entity **ViewName** provider contract search_query { .... } 546

FIG. 5

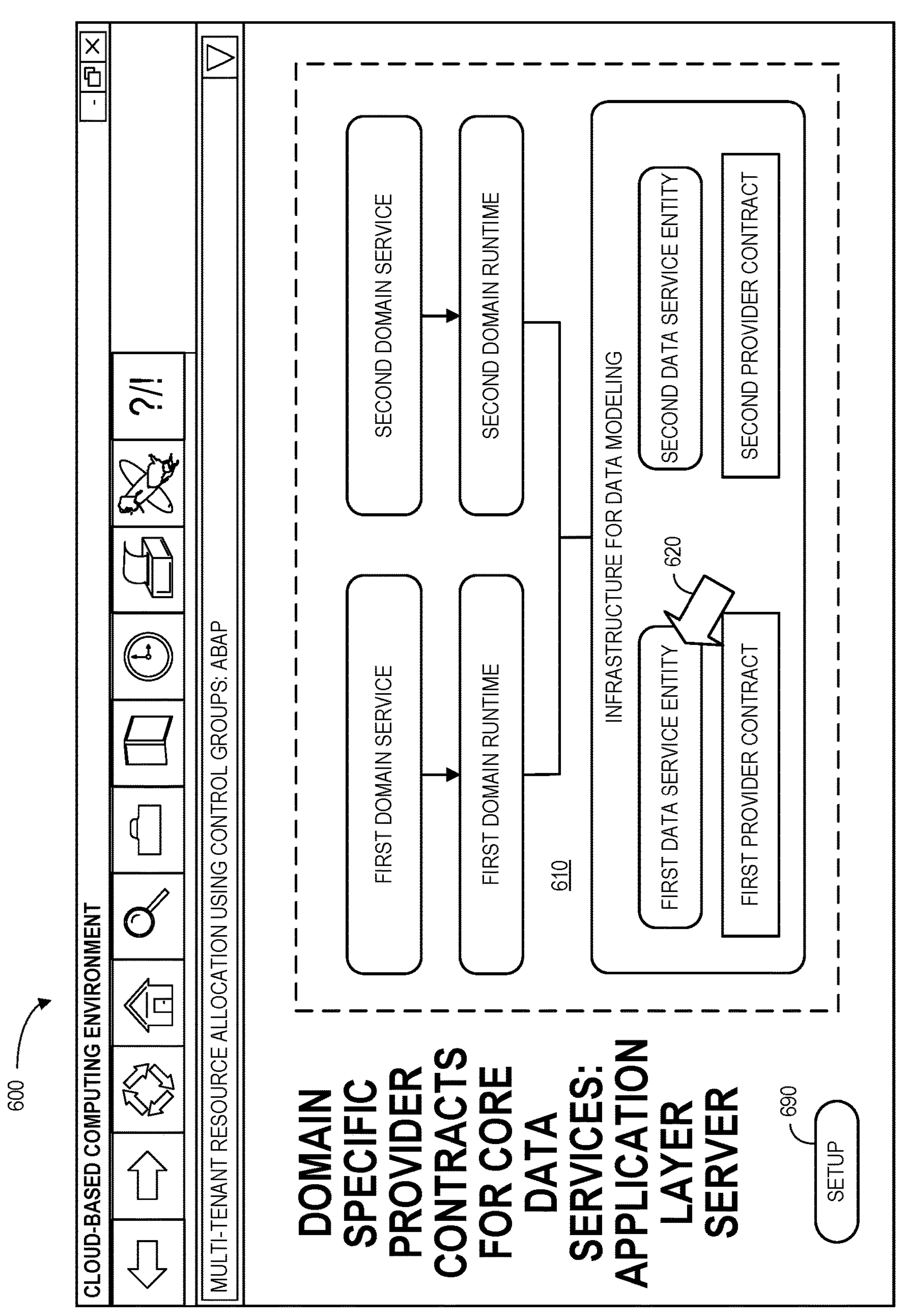

600
CLOUD-BASED COMPUTING ENVIRONMENT
?/!
MULTI-TENANT RESOURCE ALLOCATION USING CONTROL GROUPS: ABAP
DOMAIN SPECIFIC PROVIDER CONTRACTS FOR CORE DATA SERVICES: APPLICATION LAYER SERVER
690
SETUP
610
FIRST DOMAIN SERVICE
FIRST DOMAIN RUNTIME
SECOND DOMAIN SERVICE
SECOND DOMAIN RUNTIME
INFRASTRUCTURE FOR DATA MODELING
620
FIRST DATA SERVICE ENTITY
FIRST PROVIDER CONTRACT
SECOND DATA SERVICE ENTITY
SECOND PROVIDER CONTRACT

FIG. 6

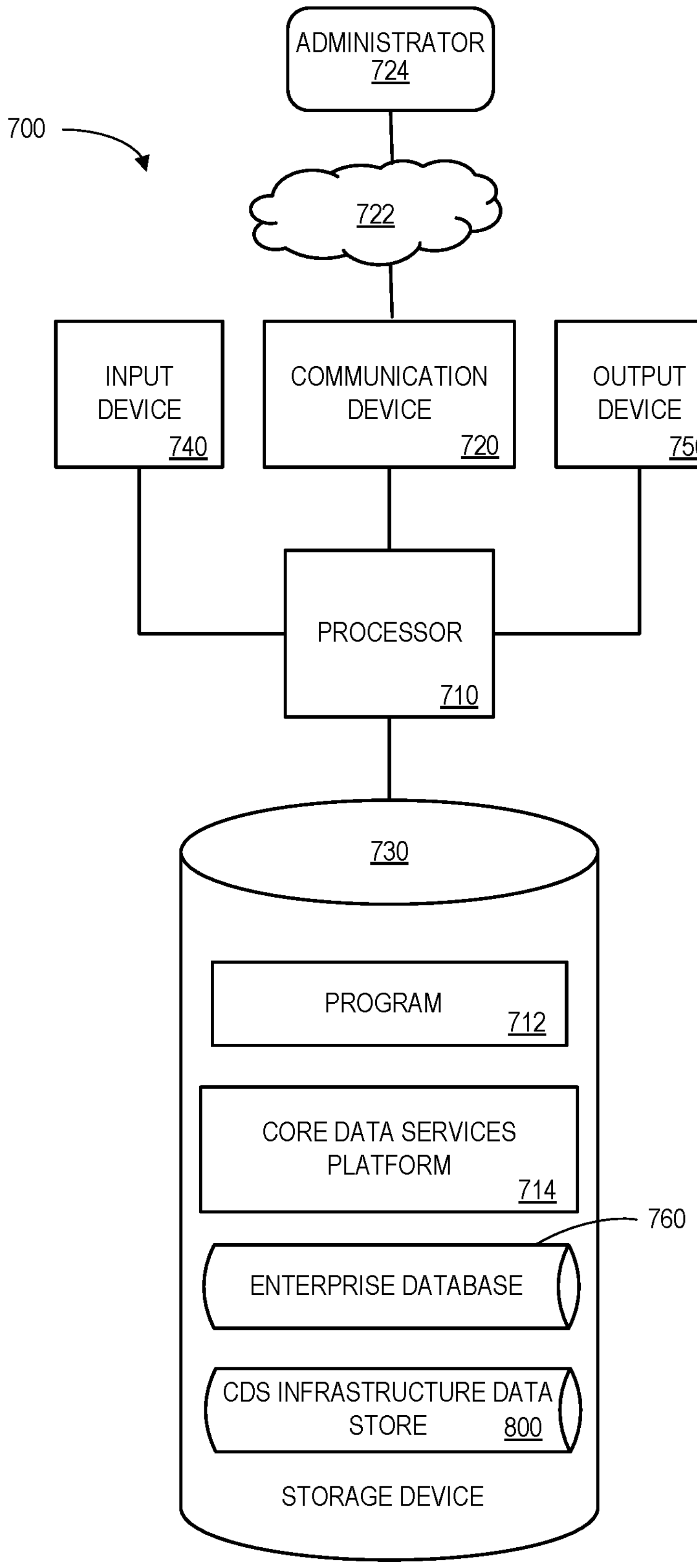
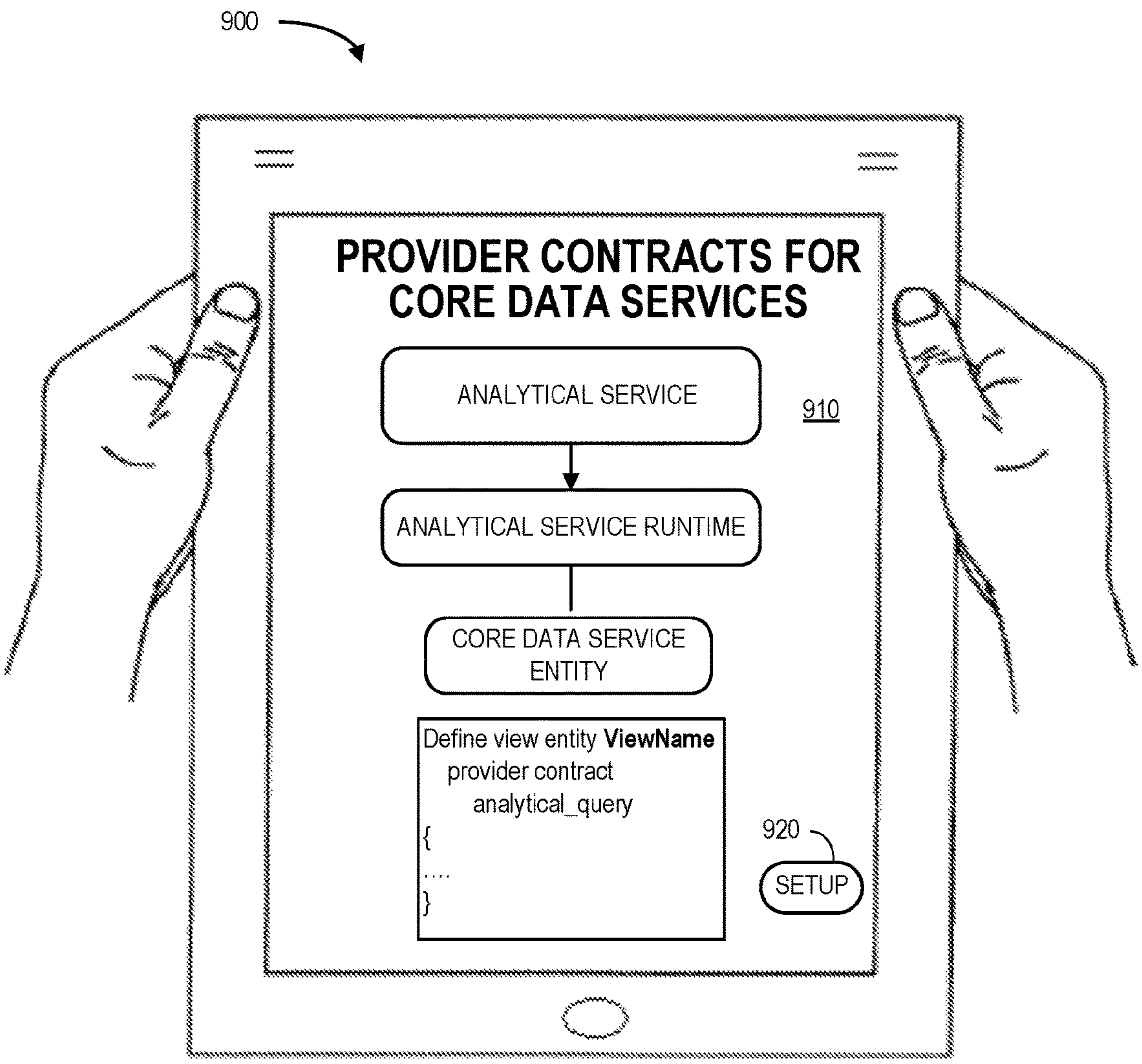

ADMINISTRATOR 724
700
722
INPUT DEVICE 740
COMMUNICATION DEVICE 720
OUTPUT DEVICE 750
PROCESSOR 710
730
PROGRAM 712
CORE DATA SERVICES PLATFORM 714
760
ENTERPRISE DATABASE
CDS INFRASTRUCTURE DATA STORE 800
STORAGE DEVICE

FIG. 7

800

DOMAIN IDENTIFIER 802	DESCRIPTION 804	RUNTIME IDENTIFIER (CDS ENTITY IDENTIFIER) 806	PROVIDER CONTRACT IDENTIFIER 808
D_102	SQL SERVICE	RT_102 (CDSE_102)	PC_102
D_104	SEARCH SERVICE	RT_104 (CDSE_104)	PC_104

FIG. 8


900
PROVIDER CONTRACTS FOR CORE DATA SERVICES
ANALYTICAL SERVICE
910
ANALYTICAL SERVICE RUNTIME
CORE DATA SERVICE ENTITY
920
SETUP

```
Define view entity ViewName
    provider contract
        analytical_query
{
....
}
```

FIG. 9

DOMAIN SPECIFIC PROVIDER CONTRACTS FOR CORE DATA SERVICES

BACKGROUND

An enterprise may utilize applications or services executing in a cloud-based computing environment. For example, a business might utilize applications that access a database at a data center to process purchase orders, human resources tasks, payroll functions, etc. The computing environment may include an enterprise database server (e.g., associated with SAP HANA® in-memory, column-oriented, relational database management system) and an application layer server, such as an Advanced Business Application Programming ("ABAP") programming language server for the mass-processing of data in business applications. Note that today's infrastructure of an ABAP server may contain multiple runtimes that can be used for modifying, reading, and processing data. For example, there might be a runtime for transactional services, a runtime for analytical services, and a runtime for search services.

These runtimes may make use of a unified Core Data Service ("CDS") model in a corresponding ABAP based application. In this way, there may be one language to model the structure of entities and the dependencies between them. For example, FIG. **1** is a high-level block diagram of a system **100** associated with a cloud-based computing system. The system **100** includes a high-level programming language server **150** that exchanges information with an enterprise database server **190**.

The high-level programming language server **150** may include a transactional service **110** and transactional service runtime **112** that accesses a CDS entity **114** in a CDS infrastructure **160**. Similarly, the high-level programming language server **150** may include: an SQL service **120** and SQL service runtime **122** that accesses a CDS entity **124**; an analytical service **130** and analytical service runtime **132** that accesses a CDS entity **134**; and a search service **140** and search service runtime **142** that accesses a CDS entity **144**. The different runtimes **112**, **122**, **132**, **142** may support different features. An ABAP dictionary may ensure that in the CDS design time model, only those features which are supported by the intended consumption scenario can be used. For example, if a CDS entity **114** is modelled for transactional services **110** then arithmetic operations are not supported in specific layers of such a business object. Currently, runtime specific checks during compile time are not possible in the CDS infrastructure **160**. Therefore, successful compilation of a runtime specific CDS artifacts cannot be prevented. This may result in runtime errors during test execution in follow-up systems and cause a time and cost intensive iterative development process (altering between development and test systems).

It would therefore be desirable to provide CDS entity modeling for a particular runtime associated with a cloud-based computing environment application layer server in an efficient and accurate manner.

SUMMARY

Methods and systems may be associated with a cloud-based computing environment. An enterprise database server may store enterprise information. An application layer server, coupled to the enterprise database server, may use an application programming language (e.g., ABAP) to access the enterprise information. The application layer server may execute a plurality of domain runtimes, each

associated with a domain service (e.g., transactional, SQL, analytical, search, etc.). The application layer server may also access, by a first domain runtime, a first data service entity in an infrastructure for data modelling (e.g., CDS) that enables data models to be defined and consumed on the enterprise database server. Similarly, the application layer server may access, by a second domain runtime, a second data service entity in the infrastructure for data modelling. According to some embodiments, the first data service entity includes a first provider contract and the second data service entity includes a second provider contract (different than the first provider contract).

Some embodiments comprise: means for executing, by at least one computer processor of an application layer server that uses an application programming language to access enterprise information, a plurality of domain runtimes, each associated with a domain service; means for accessing, by a first domain runtime, a first data service entity in an infrastructure for data modelling that enables data models to be defined and consumed on an enterprise database server rather than the application layer server, wherein the enterprise database server stores the enterprise information; and means for accessing, by a second domain runtime, a second data service entity in the infrastructure for data modelling, wherein the first data service entity includes a first provider contract and the second data service entity includes a second provider contract different than the first provider contract.

Some technical advantages of some embodiments disclosed herein are improved systems and methods to provide CDS entity modeling for a particular runtime associated with a cloud-based computing environment application layer server in an efficient and accurate manner.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a high-level block diagram of a system associated with a cloud-based computing system.

FIG. **2** is a high-level system architecture according to some embodiments.

FIG. **3** is a method in accordance with some embodiments.

FIG. **4** is a more detailed high-level system architecture according to some embodiments.

FIG. **5** is an example of a system in accordance with some embodiments.

FIG. **6** is a human machine interface display in accordance with some embodiments.

FIG. **7** is an apparatus or platform according to some embodiments.

FIG. **8** illustrates a CDS infrastructure database in accordance with some embodiments.

FIG. **9** illustrates a tablet computer displaying information about provider contracts according to some embodiments.

DETAILED DESCRIPTION

In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of embodiments. However, it will be understood by those of ordinary skill in the art that the embodiments may be practiced without these specific details. In other instances, well-known methods, procedures, components and circuits have not been described in detail so as not to obscure the embodiments.

One or more specific embodiments of the present invention will be described below. In an effort to provide a concise description of these embodiments, all features of an actual implementation may not be described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

To provide improved CDS entity modeling for a particular runtime associated with a cloud-based computing environment application layer server in an efficient and accurate manner, FIG. **2** is a high-level system **200** architecture in accordance with some embodiments. The system **200** includes an application layer server **250** that exchanges information with an enterprise database server **290**. The high-level programming language server **250** may include a first domain service **210** and first domain runtime **212** that accesses a first data service entity **214** in an infrastructure for data modeling **260**. Similarly, the application layer server **250** may include: a second domain service **220** and second domain runtime **212** that accesses a second data service entity **224**. The different domain runtimes **212**, **222** may support different features. According to some embodiments, the first data service entity **214** is associated with a first provider contact **216** and the second data service entity **224** is associated with a second provider contact **226** (different than the first provider contact **216**).

As used herein, devices, including those associated with the system **200** and any other device described herein, may exchange information via any communication network which may be one or more of a Local Area Network ("LAN"), a Metropolitan Area Network ("MAN"), a Wide Area Network ("WAN"), a proprietary network, a Public Switched Telephone Network ("PSTN"), a Wireless Application Protocol ("WAP") network, a Bluetooth network, a wireless LAN network, and/or an Internet Protocol ("IP") network such as the Internet, an intranet, or an extranet. Note that any devices described herein may communicate via one or more such communication networks.

The application layer server **250** may store information into and/or retrieve information from various data stores, which may be locally stored or reside remote from the application layer server **250**. Although a single application layer server **250** is shown in FIG. **2**, any number of such devices may be included. Moreover, various devices described herein might be combined according to embodiments of the present invention. The system **200** functions may be performed by a constellation of networked apparatuses, such as in a distributed processing or cloud-based architecture.

An operator or administrator may access the system **200** via a remote device (e.g., a Personal Computer ("PC"), tablet, or smartphone) to view information about and/or manage operational information in accordance with any of the embodiments described herein. In some cases, an interactive graphical user interface display may let an operator or administrator define and/or adjust certain parameters (e.g., to implement various mappings) and/or provide or receive automatically generated recommendations or results from the system **200**.

Note that a data model may represent a framework that organizes elements of data and standardizes how they relate to one another in a database. Data models may provide a standardized method for defining and formatting database contents consistently across systems, enabling different applications to share the same data. Professional data modeling tools provide a way to generate SQL from a modeled entity relationship diagram.

Some data models are defined and consumed in the database layer rather than in the application layer (or server **250**). One such example is SAP CDS, which is a data modeling infrastructure that provides a Data Definition Language ("DDL") for defining semantically rich database tables/views (CDS views) and user-defined types in the database. CDS provides support for conceptual modeling and relationship definitions, built-in functions, and extensions.

Data models may be defined as views (e.g., CDS views), which can be used in applications (e.g., Fiori applications) to enable access to the database. Data model views may be created as design-time files and natively integrated into the database layer to take advantage of in-memory database computing (e.g., SAP HANA®) to achieve good performance for high data volume. However, the database layer may be unable to handle customized complex calculations. Such customized calculations are typically programmed within the application using an application programming language (e.g., SAP ABAP). Application logic (e.g., data reading, processing, output), programmed using such application programming language, is suitable for processing small to medium data volumes and customized complex calculations. The application is typically executed within an application layer (e.g., SAP NETWEAVER®), while the data model view is run within the database layer (e.g., SAP HANA®). Therefore, application logic may be inserted before or after the execution of the data model (e.g., CDS view).

FIG. **3** is a method that might performed by some or all of the elements of any embodiment described herein. The flow charts described herein do not imply a fixed order to the steps, and embodiments of the present invention may be practiced in any order that is practicable. Note that any of the methods described herein may be performed by hardware, software, an automated script of commands, or any combination of these approaches. For example, a computer-readable storage medium may store thereon instructions that when executed by a machine result in performance according to any of the embodiments described herein.

At S**310**, at least one computer processor of an application layer server (e.g., that uses an application programming language such as ABAP to access enterprise information) may execute a plurality of domain runtimes, each associated with a domain service (e.g., a transactional service, an SQL service, an analytical service, a search service, etc.). At S**320**, a first domain runtime may access a first data service entity in an infrastructure for data modelling. The infrastructure for data modelling may, for example, enable data models to be defined and consumed on an enterprise database server rather than the application layer server (e.g., a CDS infrastructure). Moreover, the enterprise database server may store the enterprise information. At S**330**, a second domain runtime may access a second data service entity in the infrastructure for data modelling. According to some embodiment, the first data service entity includes a first provider contract and the second data service entity includes a second provider contract (different than the first provider contract).

FIG. **4** is a more detailed high-level system **400** architecture according to some embodiments. The system **400** includes an ABAP server **450** that exchanges information with a HANA enterprise database server **490**. The ABAP server **450** may include a first domain service **410** and first domain runtime **412** that accesses a first data service entity **414** in a CDS infrastructure **460**. Similarly, the ABAP server **450** may include: a second domain service **420** and second domain runtime **422** that accesses a second data service entity **424**. According to some embodiments, the first data service entity **414** is associated with a first provider contact **416** and the second data service entity **424** is associated with a second provider contact **426** (different than the first provider contact **416**).

FIG. **5** is an example of a system **500** in accordance with some embodiments. As before the system **500** includes an ABAP server **550** that exchanges information with a HANA enterprise database server (not shown in FIG. **5**). The ABAP server **550** may include a transactional service **510** and transactional service runtime **512** that accesses a CDS entity **514** in a CDS infrastructure **560**. Similarly, the ABAP server **550** may include: an SQL service **520** and SQL service runtime **522** that accesses a CDS entity **524**; an analytical service **530** and analytical service runtime **532** that accesses a CDS entity **534**; and a search service **540** and search service runtime **542** that accesses a CDS entity **544**.

The CDS entity **514** in the CDS infrastructure **560** that is associated with the transactional service **510** may include a transactional provider contract **516** (e.g., defining view entity ViewName provider contract for a transactional_query).

Similarly, the CDS entity **524** in the CDS infrastructure **560** that is associated with the SQL service **520** may include a SQL provider contract **526** (e.g., defining view entity ViewName provider contract for a SQL_query). Likewise, the CDS entity **534** that is associated with the analytical service **530** may include an analytical provider contract **536** (e.g., defining view entity ViewName provider contract for an analytical_query), and the CDS entity **544** that is associated with the search service **540** may include a search provider contract **546** (e.g., defining view entity ViewName provider contract for a search_query).

As used herein, the phrase "provider contract" may be associated with, for example, a scenario in which a CDS projection view is used. The scenario may determine in which runtime a CDS projection view is executed and which features are available. Specifying the provider contract may help ensure that the appropriate, runtime-specific syntax checks are applied.

In this way, embodiments may specifically model a CDS entity **514**, **524**, **534**, **544** for a particular runtime **512**, **522**, **532**, **542** inside the ABAP server **550**. This feature may enable, for example:

- additional checks during compilation of the design time artifact of a CDS entity **514**, **524**, **534**, **544**;
- detailed hints and auto-completions for editors;
- fine-grained release checks of specific CDS entities **514**, **524**, **534**, **544** (relevant for extensibility scenarios); and
- introduction of new features inside the core CDS infrastructure **560** (even if it is not SQL based).

This may result in a reduction of the Total Costs of Development ("TCD"). Further, runtimes inside the ABAP server **550** can rely on such provider contracts **516**, **526**, **536**, **546**, which may result in:

- no runtime abortion for unsupported features anymore (already shown in the design time development of CDS entities **514**, **524**, **534**, **544**); and
- no sanity checks needed anymore by the corresponding runtimes **512**, **522**, **532**, **542** (which can cause a reduction of TCD and faster runtimes).

In the past, runtime specific checks during compile time have not been possible in the CDS infrastructure **560**. Therefore, successful compilation of a runtime specific CDS artifacts could not be prevented. This could result in runtime errors in target test systems. A time and cost intensive iterative development process (in both the development and test system) was required. According to some embodiments, provider contracts **516**, **526**, **536**, **546** will support runtime specific checks during compile time, and therefore allow development of runtime specific CDS artifacts in the development system only.

FIG. **6** is a human machine interface display **600** associated with an ABAP server runtime in accordance with some embodiments. The display **600** includes a graphical representation **610** of elements of a cloud-based computing environment system. Selection of an element (e.g., via a touchscreen or computer pointer **620**) may result in display of a pop-up window containing various options (e.g., to adjust mappings, add or delete domains, define provider contracts, etc.). The display **600** may also include a user-selectable "Setup" icon **690** (e.g., to configure parameters for cloud management, runtimes, and/or or CDS as described with respect any of the embodiments of FIGS. **2** through **5**).

Note that the embodiments described herein may be implemented using any number of different hardware configurations. For example, FIG. **7** is a block diagram of an apparatus or platform **700** that may be, for example, associated with the system **200** of FIG. **2** (and/or any other system described herein). The platform **700** comprises a processor **710**, such as one or more commercially available Central Processing Units ("CPUs") in the form of one-chip microprocessors, coupled to a communication device **720** configured to communicate via a communication device **720**. The communication device **720** may be used to communicate, for example, with one or more remote user or administrator **724** devices via a communication network **722**. The platform **700** further includes an input device **740** (e.g., a computer mouse and/or keyboard to input provider contract details) and/an output device **750** (e.g., a computer monitor to render a display, transmit recommendations, and/or create data center reports). According to some embodiments, a mobile device and/or PC may be used to exchange information with the platform **700**.

The processor **710** also communicates with a storage device **730**. The storage device **730** can be implemented as a single database or the different components of the storage device **730** can be distributed using multiple databases (that is, different deployment information storage options are possible). The storage device **730** may comprise any appropriate information storage device, including combinations of magnetic storage devices (e.g., a hard disk drive), optical storage devices, mobile telephones, and/or semiconductor memory devices. The storage device **730** stores a program **712** and/or CDS platform **714** for controlling the processor **710**. The processor **710** performs instructions of the programs **712**, **714**, and thereby operates in accordance with any of the embodiments described herein. For example, the processor **710** may access an enterprise database **760** that stores enterprise information. The processor **710** may use an application programming language (e.g., ABAP) to access the enterprise information. The processor **710** may execute a plurality of domain runtimes, each associated with a domain service (e.g., transactional, SQL, analytical, search, etc.). The processor **710** may also access, by a first domain runtime, a first data service entity via the CDS platform **714** that enables data models to be defined and consumed on the enterprise database server. Similarly, the processor **710** may access, by a second domain runtime, a second data service entity in the CDS platform **714**. According to some embodiments, the first data service entity includes a first provider contract and the second data service entity includes a second provider contract (different than the first provider contract).

The programs **712**, **714** may be stored in a compressed, uncompiled and/or encrypted format. The programs **712**, **714** may furthermore include other program elements, such as an operating system, clipboard application, a database management system, and/or device drivers used by the processor **710** to interface with peripheral devices.

As used herein, information may be "received" by or "transmitted" to, for example: (i) the platform **700** from another device; or (ii) a software application or module within the platform **700** from another software application, module, or any other source.

In some embodiments (such as the one shown in FIG. **7**), the storage device **730** further stores the enterprise database **760** and a CDS infrastructure data store **800**. An example of a database that may be used in connection with the platform **700** will now be described in detail with respect to FIG. **8**. Note that the database described herein is only one example, and additional and/or different information may be stored therein. Moreover, various databases might be split or combined in accordance with any of the embodiments described herein.

Referring to FIG. **8**, a table is shown that represents the CDS infrastructure data store **800** that may be stored at the platform **700** according to some embodiments. The table may include, for example, entries that define provider contracts for various domains. The table may also define fields **802**, **804**, **806**, **808**, for each of the entries. The fields **802**, **804**, **806**, **808** may, according to some embodiments, specify: a domain identifier **802**, a description **804**, runtime and CDS entity identifiers **806**, and a provider contract identifier **808**. The CDS infrastructure data store **800** may be created and updated, for example, when a new domain is added or deleted, an existing domain is adjusted, etc. According to some embodiments, the CDS infrastructure data store **800** may further store details about an enterprise database server.

The domain identifier **802** might be a unique alphanumeric label or link that is associated with a service supported by an application layer server. The description **804** might describe the service associated with that domain (e.g., transactional, SQL, analytical, search, etc.). The runtime and CDS entity identifiers **806** may define a service runtime and CDS entity for the domain associated with the domain identifier **802**. The provider contract identifier **808** may comprise a domain specific provider contract in accordance with any of the embodiments described herein (e.g., defining view entity ViewName provider contract for a query).

Thus, embodiments may provide CDS entity modeling for a particular runtime associated with a cloud-based computing environment application layer server in an efficient and accurate manner. The following illustrates various additional embodiments of the invention. These do not constitute a definition of all possible embodiments, and those skilled in the art will understand that the present invention is applicable to many other embodiments. Further, although the following embodiments are briefly described for clarity, those skilled in the art will understand how to make any changes, if necessary, to the above-described apparatus and methods to accommodate these and other embodiments and applications.

Although specific hardware and data configurations have been described herein, note that any number of other configurations may be provided in accordance with some embodiments of the present invention (e.g., some of the information associated with the databases described herein may be combined or stored in external systems). Moreover, although some embodiments are focused on particular types of database applications and services, any of the embodiments described herein could be applied to other types of applications and services. In addition, the displays shown herein are provided only as examples, and any other type of user interface could be implemented. For example, FIG. **9** shows a tablet computer **900** rendering information about provider contracts **910**. The information about provider contracts **910** may, according to some embodiments, be used to view more detailed elements about components of the system (e.g., when a graphical element is selected via a touchscreen) or to configure operation of the system (e.g., to establish new mappings or domains for the system via a "Setup" icon **920**).

The present invention has been described in terms of several embodiments solely for the purpose of illustration. Persons skilled in the art will recognize from this description that the invention is not limited to the embodiments described, but may be practiced with modifications and alterations limited only by the spirit and scope of the appended claims.

The invention claimed is:

1. A system associated with a cloud-based computing environment, comprising:

an enterprise database server storing enterprise information; and

an application layer server, coupled to the enterprise database server, that uses an application programming language to access the enterprise information, including:

at least one computer processor, and

a memory storage device including instructions that, when executed by the at least one computer processor, enable the application layer server to:

execute a plurality of domain runtimes, each associated with a domain service,

access, by a first domain runtime, a transactional service entity in a Core Data Services ("CDS") infrastructure for data modelling that enables data models to be defined and consumed on the enterprise database server rather than the application layer server,

access, by a second domain runtime, a Structured Query Language ("SQL") service entity in the CDS infrastructure for data modelling,

access, by a third domain runtime, an analytical service entity in the CDS infrastructure for data modelling, and

access, by a fourth domain runtime, a search service entity in the CDS infrastructure for data modelling,

wherein the transactional, SQL, analytical, and search service entities each include a different provider contract enabling: additional checks during compilation of a design time artifact of a CDS entity; detailed hints and auto-completions for an editor; no run time halts for unsupported features; and no run time sanity check.

2. The system of claim **1**, wherein the application programming language is associated with Advanced Business Application Programming ("ABAP").

3. The system of claim 2, wherein each provider contract enables fine-grained release checks for specific CDS entities.

4. The system of claim 3, wherein each provider contract enables an introduction of new features inside the CDS infrastructure.

5. A computer-implemented method associated with a cloud-based computing environment, comprising:

executing, by at least one computer processor of an application layer server that uses an application programming language to access enterprise information, a plurality of domain runtimes, each associated with a domain service;

accessing, by a first domain runtime, a transactional service entity in a Core Data Services ("CDS") infrastructure for data modelling that enables data models to be defined and consumed on an enterprise database server rather than the application layer server, wherein the enterprise database server stores the enterprise information;

accessing, by a second domain runtime, a Structured Query Language ("SQL") service entity in the CDS infrastructure for data modelling;

accessing, by a third domain runtime, an analytical service entity in the CDS infrastructure for data modelling; and

accessing, by a fourth domain runtime, a search service entity in the CDS infrastructure for data modelling,

wherein the transactional, SQL, analytical, and search service entities each include a different provider contract enabling: additional checks during compilation of a design time artifact of a CDS entity; detailed hints and auto-completions for an editor; no run time halts for unsupported features; and no run time sanity check.

6. The method of claim 5, wherein the application programming language is associated with Advanced Business Application Programming ("ABAP").

7. A non-transitory, computer-readable medium storing instructions, that, when executed by a processor, cause the

processor to perform a method associated with a cloud computing environment, the method comprising:

executing, by at least one computer processor of an application layer server that uses an application programming language to access enterprise information, a plurality of domain runtimes, each associated with a domain service;

accessing, by a first domain runtime, a transactional service entity in a Core Data Services ("CDS") infrastructure for data modelling that enables data models to be defined and consumed on an enterprise database server rather than the application layer server, wherein the enterprise database server stores the enterprise information;

accessing, by a second domain runtime, a Structured Query Language ("SQL") service entity in the CDS infrastructure for data modelling;

accessing, by a third domain runtime, an analytical service entity in the CDS infrastructure for data modelling; and

accessing, by a fourth domain runtime, a search service entity in the CDS infrastructure for data modelling,

wherein the transactional, SQL, analytical, and search service entities each include a different provider contract enabling: additional checks during compilation of a design time artifact of a CDS entity; detailed hints and auto-completions for an editor; no run time halts for unsupported features; and no run time sanity check.

8. The medium of claim 7, wherein the application programming language is associated with Advanced Business Application Programming ("ABAP").

9. The medium of claim 7, wherein each provider contract enables fine-grained release checks for specific CDS entities.

10. The medium of claim 9, wherein each provider contract enables an introduction of new features inside the CDS infrastructure.

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